CLINICALLY ORIENTED Anatomy

THIRD EDITION

KEITH L. MOORE

B.A., M.Sc., Ph.D., F.I.A.C., F.R.S.M.
Professor of Anatomy and Cell Biology
Faculty of Medicine, University of Toronto
Toronto, Ontario, Canada
Visiting Professor of Clinical Anatomy
Department of Anatomy, Faculty of Medicine
University of Manitoba
Winnipeg, Manitoba, Canada

ILLUSTRATED PRIMARILY BY

Dorothy Chubb, Elizabeth Blackstock, Jean Calder, Dorothy Irwin, Nina Kilpatrick, David Mazierski, Angela Cluer, Stephen Mader, Bart Vallecoccia, Sari O'Sullivan, and Kam Yu

PHOTOGRAPHY BY

John Kozie and Paul Schwartz

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Accurate indications, adverse reactions, and dosage schedules for drugs are provided in this book, but it is possible that they may change. The reader is urged to review the package information data of the manufacturers of the medications mentioned.

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may be reduced or stopped. This may also result in the death of neurons in this region of the cord, and these patients may also lose sensation and voluntary movement in the areas supplied by the affected level of the spinal cord.

The vertebral venous plexuses are important clinically because blood may return from the pelvis or abdomen through them and reach the heart via the superior vena cava (see Figs. 1-73 and 1-76). When the prostate is cancerous (p. 281), blood may pass from it to the vertebral venous plexuses and the superior vena cava, instead of by its usual route via the internal iliac veins and inferior vena cava (see Fig. 2-105). Tumor cells from a prostatic cancer may also be deposited via these veins in the vertebrae, where secondary cancers may develop.

The vertebral canal varies considerably in size and shape from level to level, particularly in the cervical and lumbar regions (Figs. 4-13, 4-14, and 4-20). A small vertebral canal in the cervical region, into which the spinal cord fits tightly, is potentially dangerous because a minor fracture and/or dislocation of the cervical vertebrae may damage the spinal cord (Fig. 4-37). The protrusion of a cervical intervertebral disc (*herniated nucleus pulposus*) into the vertebral canal after a neck injury may cause "spinal cord shock," associated with paralysis inferior to the site of the lesion. In some cases no fracture or dislocation of cervical vertebrae can be found. If the patient dies, a softening of the spinal cord may be found at the site of the *cervical disc protrusion*.

Encroachment of the vertebral canal by a protruding intervertebral disc, swollen ligamenta flava, or as the result of *osteoarthritis of the zygapophyseal (facet) joints*, may exert pressure on one or more of the nerve roots of the cauda equina (Figs. 4-29*B* and 4-32). Pressure may produce sensory and motor symptoms in the areas concerned. This group of bone and joint abnormalities, which causes pain and stiffness, is often called *lumbar spondylosis* (degenerative joint disease affecting the lumbar vertebrae and intervertebral discs). *Cervical spondylosis* is often accompanied by swollen ligamenta flava and osteoarthritis of the zygapophyseal joints. In these conditions, there is usually encroachment on the intervertebral foramina and/or vertebral canal. This may cause pressure on the cervical spinal nerve roots and/or spinal cord, resulting in various neurological symptoms and signs.

In some elderly people, the nuclei pulposi of the intervertebral discs degenerate, the vertebrae come together, and the anuli fibrosi bulge anteriorly, posteriorly, and laterally. This leads to the formation of bony outgrowths called *osteophytes* that may produce pressure on the spinal nerve roots and cause sensory and motor symptoms. **Transection of the spinal cord** results in loss of all sensation and voluntary movement inferior to the lesion. *The patient is quadriplegic if the cervical cord superior to C3 is transected*, and the patient may die owing to respiratory failure. The patient is paraplegic if the transection is between the cervical and lumbosacral enlargements (Fig. 4-52).

The Spinal Meninges and CSF

The dura mater, arachnoid mater, and pia mater are known collectively as the *meninges* (G. membranes). These non-nervous membranes surround and support the spinal cord (Figs. 4-15, 4-49 to 4-51, and 4-54). The cavity between the bony and ligamentous walls of the vertebral canal and the dura is called the *extradural (epidural) space*. It contains fat, loose connective tissue, and the anterior and posterior vertebral venous plexuses (Fig. 4-53*A*). Between the dura and arachnoid there is a potential space, called the *subdural space*,[4] containing only a capillary layer of fluid. Between the arachnoid and pia there is an actual space, called the *subarachnoid space*, which contains *CSF* and the vessels of the spinal cord (Figs. 4-49*B*, 4-50, and 4-55*B*).

The Dura Mater (Figs. 4-45, 4-48 to 4-51, and 4-54). The spinal dura mater (L. *dura*, hard, + *mater*, mother), the tough, *outermost covering membrane* of the spinal cord, is composed of white fibrous and elastic tissue. The spinal dura forms a long tubular sheath or *dural sac* that is free within the vertebral canal. It is adherent to the margin of the foramen magnum of the skull, where it is *continuous with the cranial dura mater*. The spinal cord is suspended in this dural sac by a saw-toothed **denticulate ligament** (L. *dentatus*, toothed) on each side. This ribbon-like ligament, composed of pia mater, is attached along the lateral surface of the spinal cord, midway between the dorsal and ventral nerve roots. The lateral edges of the denticulate ligament are notched or serrated (L. *serratus*, a saw). The 21 tooth-like processes of the ligament are attached to the dura mater between the nerve roots. Their attachment is to the periosteum starting at the foramen magnum; the last one is between T12 and L1 nerve roots.

The spinal dura mater extends into the intervertebral foramina (Fig. 4-15) and evaginates along the dorsal and ventral nerve roots of the spinal nerves and spinal ganglia to form *dural root sleeves* (Figs. 4-49 to 4-51). These sleeves adhere to the periosteum lining the intervertebral foramina and end by blending with the epineurium of the spinal nerves (see Fig. 25, p. 28).

The Arachnoid Mater (Figs. 4-15, 4-49 to 4-51, and 4-54). The arachnoid (G. spider-like) is the delicate, filamentous, avascular *intermediate covering membrane* of the spinal cord. It is composed of white fibrous and elastic tissue and is coextensive with the dura mater. However, it is separated from this external layer by a potential *subdural space* which contains a film of fluid, just enough to moisten the apposed membrane surfaces. The arachnoid is separated from the pia mater by an actual space, the *subarachnoid space*, but the pia and arachnoid layers are connected by delicate strands of connective tissue called *arachnoid trabeculae* (see Fig. 7-44*B*). The arachnoid also covers the spinal nerve roots and spinal ganglia and blends with the sheaths of the spinal nerves. It also ensheaths the cauda equina and follows the dural sac to its termination at the S2 vertebral level.

The Pia Mater (Figs. 4-15, 4-49, 4-50, and 4-54). The spinal pia mater (L. *pius*, tender, + *mater*, mother), the *innermost covering membrane* of the spinal cord, is composed of two fused layers of loose connective tissue. It encloses a network of blood vessels and adheres closely to the surface of the spinal cord. It also covers the roots of the spinal nerves and spinal blood vessels and ensheaths the anterior spinal artery with a glistening longitudinal band of fibers known as the *linea splendens*. The pia mater is continuous with the *denticulate ligament* on each side of the spinal cord. Inferior to the conus medullaris

[4]The existence of this potential space has recently been questioned (see p. 687).